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NATIONAL WELFARE IN AN OPEN ECONOMY IN THE PRESENCE OF FOREIGN-OWNED FACTORS OF PRODUCTION*

Jagdish Bhagwati and Richard Brecher

Number 224 October 1978

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I: Introduction

In the presence of foreign-owned factors of production in an economy, the traditional conclusions regarding the effects of exogenous parametric changes or policy changes on national welfare need to be modified. Thus, in an open economy, the absence of the usual foreign and domestic distortions *a la* Bhagwati (1971) and Johnson (1965) will not ensure that an exogenous term-of-trade improvement or a policy shift from autarky to free trade will improve national welfare.

For example, take the traditional 2x2 model of trade theory and assume that the importable good is labour-intensive, labour is wholly national and capital is wholly foreign. A shift from autarky to free trade will then, by lowering the relative domestic price of the importable good, lower the real wage of labour *a la* Stolper-Samuelson (1941) and thereby result in national immiserization from the shift to free trade. Free trade therefore worsens rather than improves welfare, given the presence of foreign capital in this example.

Bhagwati and Tironi (1978) have analyzed this particular problem recently for the 2x2 model, allowing the tariff to vary by policy, but assuming that each of the two factors of production is wholly foreign or wholly national. This latter assumption permits them to adapt readily to their problem the well-known results on income distribution by factor class, originating from Stolper-Samuelson (1941) and developed in Bhagwati (1959) and Rao (1971).

Unfortunately, the real world does not permit us to divide all factors exclusively into the national or the foreign category. Capital flows to countries that cannot be assumed to have no capital of their

own, and labour moves into countries that surely have native populations. Thus, it is necessary for this reason alone to examine the problem at hand by permitting the factors of production to be both national and foreign, as we do presently.

But, from a theoretical viewpoint as well, this generalized formulation of the problem is important, in yielding insights which are at variance with those obtained from the restrictive characterization of each factor as either wholly national or wholly foreign. Moreover, our geometrical analysis of this general case may be seen as being complementary to Johnson's (1959) (1960) celebrated geometrical treatment of the restrictive case, which indeed is a subset of the possibilities that we distinguish and analyze in the general case.

In section II we trace the effects of variation in the goods price-ratio on the income accruing to national factors, thus defining their "income line" at alternative price-ratios. In section III, we relate this perfectly general analysis first to exogenously-induced changes in external terms of trade, assuming free trade, and therewith discuss the effects on national welfare that would follow from such changes. We also relate the analysis next to effects of tariff variation on national welfare.

II: National Income Variations as Goods Price-Ratio is Varied

The first problem that we analyze relates to the behavior of the national "income line" as the prevailing price-ratio for goods is varied.

The model has two factors of production, K (for capital) and L (for labour). The overall factor endowment is $\bar{K}$ and $\bar{L}$, while the national (i.e., domestically-owned) factor endowment is $\bar{K}_n$ and $\bar{L}_n$. The two traded goods are X and Y.

With the usual restrictions on the linear homogeneous production functions for the two goods, and assuming the absence of factor-intensity reversals for the rest of our analysis, we can define an aggregate production possibility curve, $T_x'T_y'$ in Figure 1 for the aggregate factor endowments $(\bar{K}, \bar{L})$. For the usual trade-theoretic analysis, with well-behaved social utility curves, a goods price-ratio AB will be defined for autarky and the utility index U^G would rise monotonically as P_x/P_y (the relative price of X in terms of Y) was varied up from A to T_x' or down from A to T_y' (with reversed pattern of trade). (For simplicity of exposition, we assume that all income earned by factors from abroad is consumed locally, to avoid having to show repatriation of such income in Figure 1.) This relationship between P_y/P_x and U^G, as illustrated in Figure 2, follows from deriving first the implication of the goods price-ratio variation for the aggregate budget line and then deducing the welfare level (U^G) achieved in Figure 1.

For national welfare, however, we need to define these two steps for domestically-owned factors alone. First, as in this section, we must derive the national budget line, as defined by the domestic goods price-

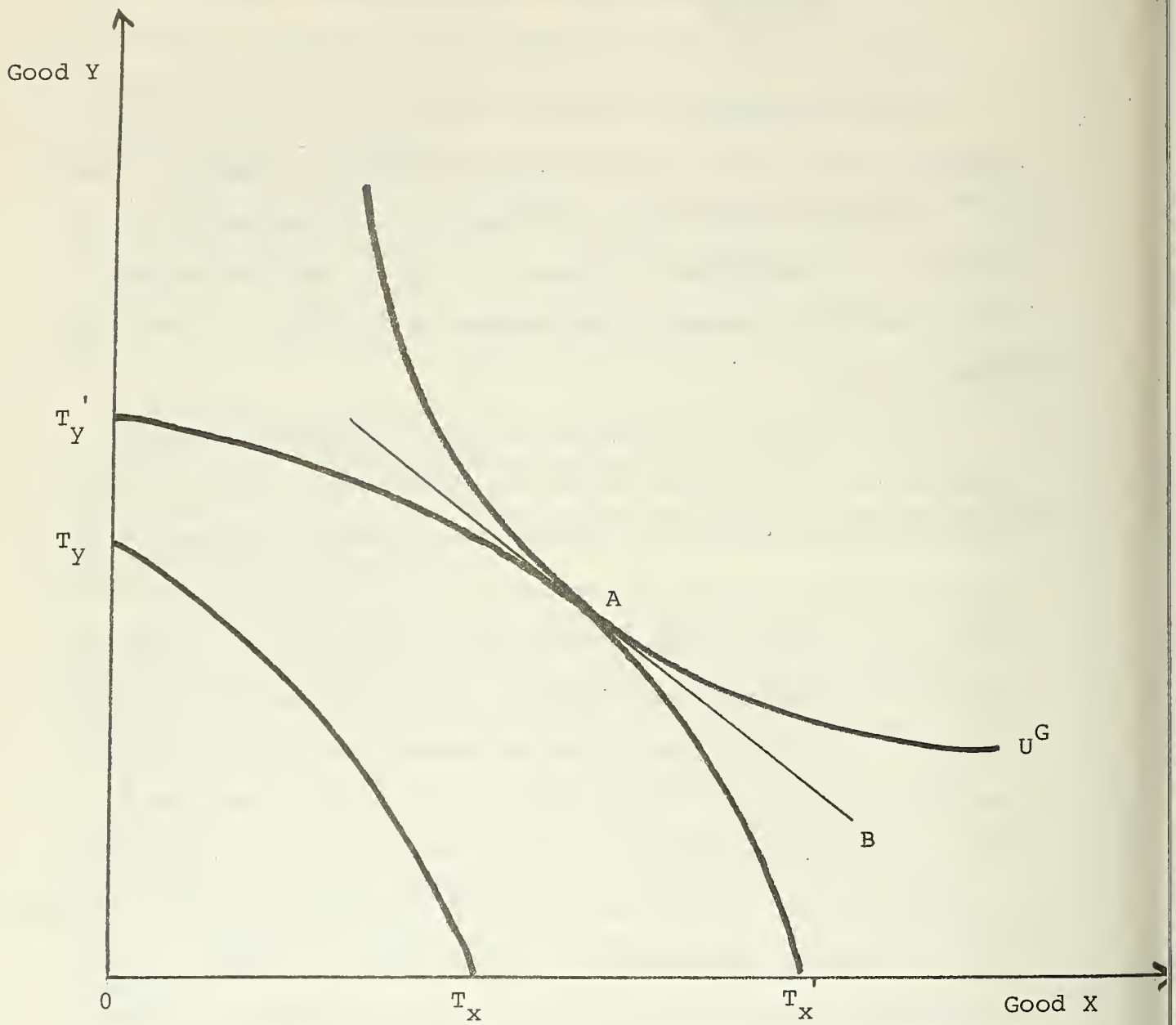

FIGURE 1

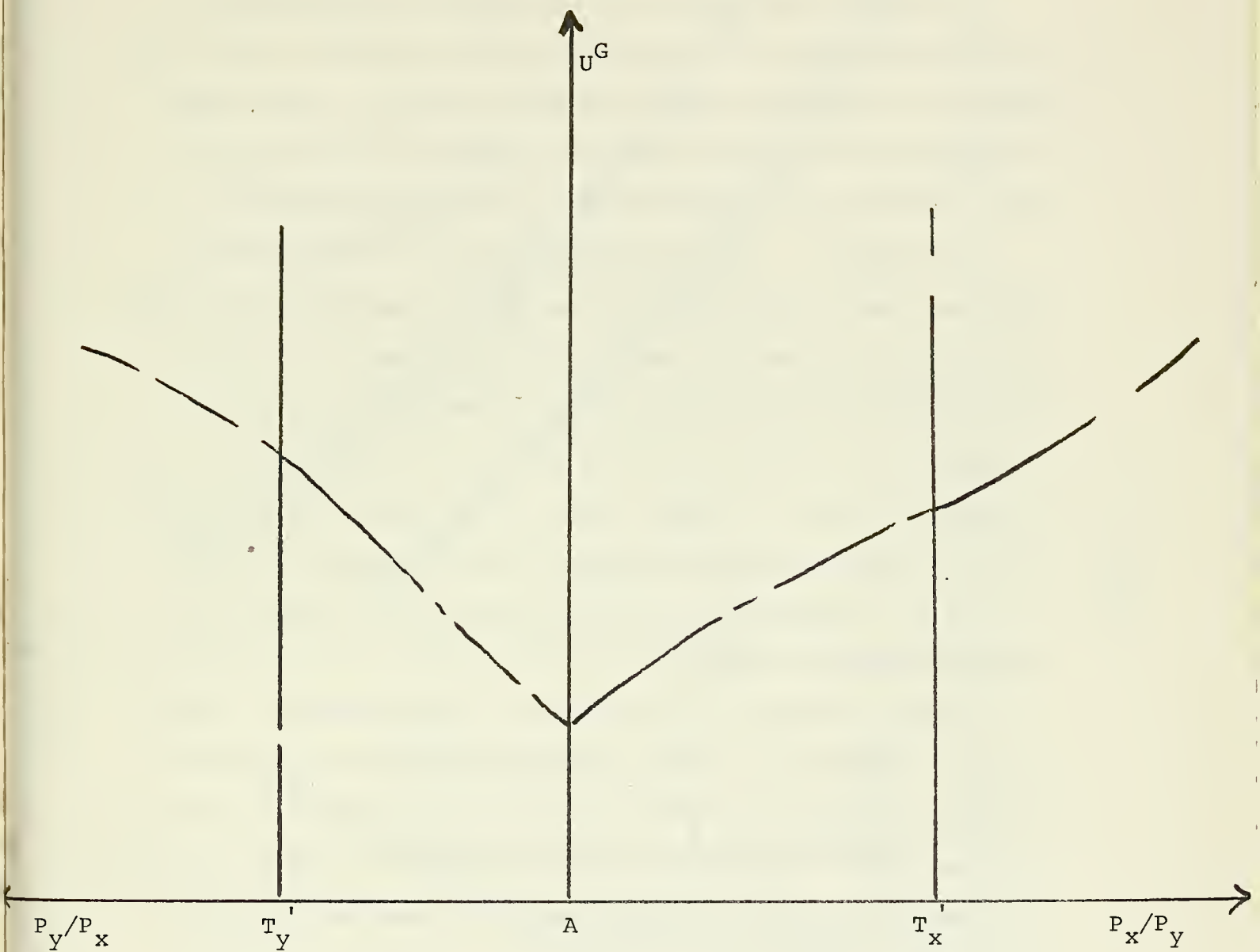

FIGURE 2

ratio. Next, as in the following section, we must deduce the national welfare level (U^N) reached in consequence.

The natural way to proceed with the analysis then would appear to be to draw onto Figure 1 the national production possibility curve, T_xT_y, defined by the domestically-owned endowments $\bar{K}_n$ and $\bar{L}_n$. One may then be tempted to draw the goods price-ratio tangent to it, as to $T_x'T_y'$, and to treat the resulting income line as the national budget line.

But, except for a range of possible cases, this cannot be done. To see why, and to state the correct and complete analysis of the problem, let us turn to the familiar Samuelson diagram in Figure 3 -- which relates the goods price-ratio (P_y/P_x), the factor-price (rental-wage) ratio P_K/P_L, and the sectoral capital-labour ratios K_x/L_x (for good X) and K_y/L_y (for good Y). Assume, without loss of generality, that $\bar{K}_n/\bar{L}_n < \bar{K}/\bar{L}$, i.e., the foreign-owned endowment is capital intensive (as would be the case if foreign capital alone had come into the country a la Bhagwati and Tironi (1978)).

There are two cases that can arise then: either there is a range of factor price-ratios at which incomplete specialization will obtain on both T_xT_y and $T_x'T_y'$ or there is no such range. Figure 3 illustrates the former, more interesting case; the latter, which corresponds incidentally to the Bhagwati-Tironi restrictive case, will be analyzed subsequently and related to the former.

The analysis then must distinguish among three zones of goods price-ratios: Zone I where they lead to incomplete specialization in production for both the production possibility curves T_xT_y and $T_x'T_y'$; Zone II where complete specialization on the capital-intensive good X occurs on $T_x'T_y'$ before it does on the national curve T_xT_y; and Zone III where

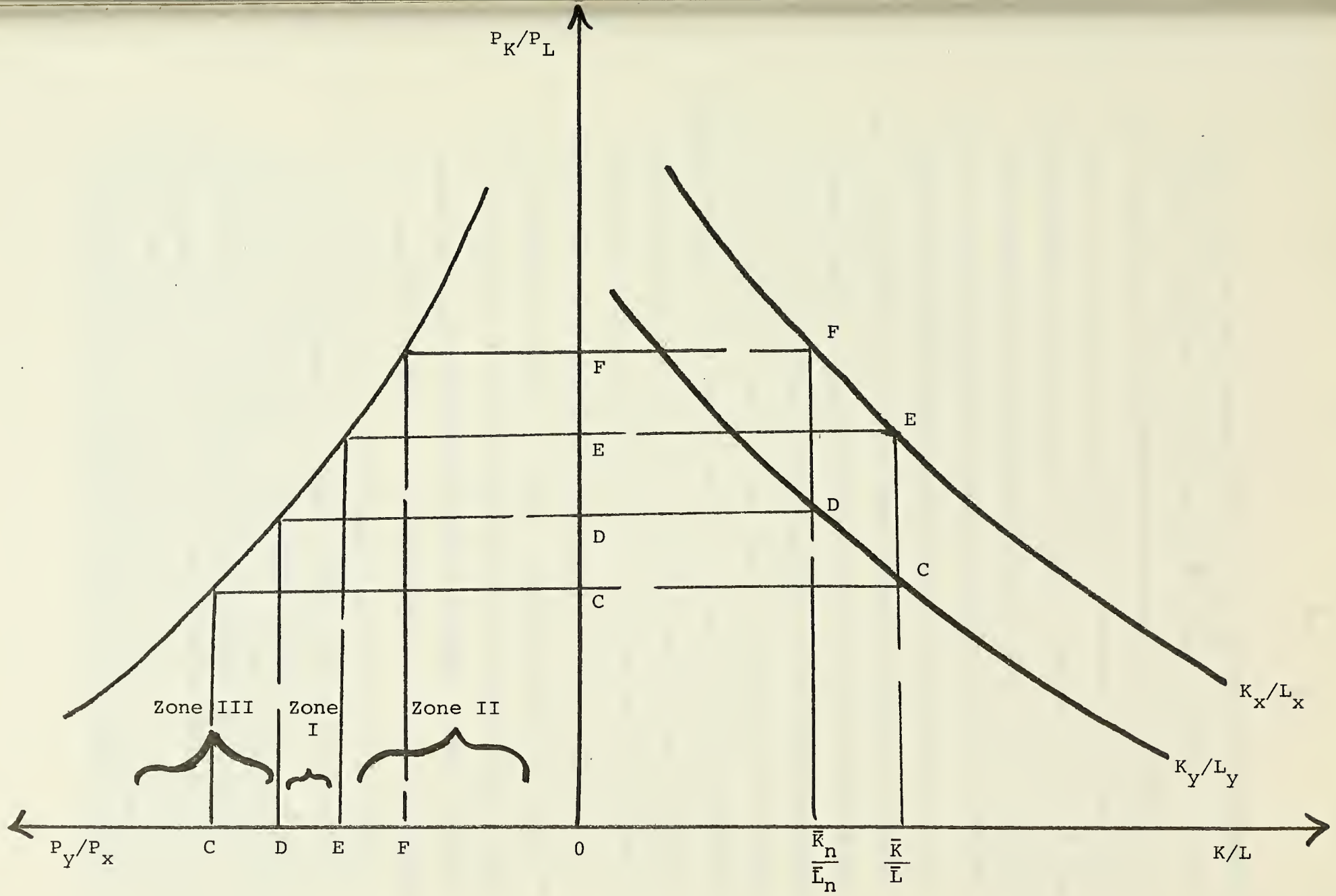
P_K/P_L
F
E
D
C
F
E
D
C
Zone III
Zone I
Zone II
K_x/L_x
K_y/L_y
P_y/P_x
C
D
E
F
0
$\frac{\bar{K}_n}{\bar{L}_n}$
$\frac{\bar{K}}{\bar{L}}$
K/L

FIGURE 3

complete specialization on the labour-intensive good Y occurs on T_xT_y before it occurs on the aggregate curve $T_x'T_y'$. Take each, in turn.

Zone I: For the aggregate endowment ratio, $\bar{K}/\bar{L}$, the range of factor price-ratios for incomplete specialization is clearly CE (i.e., OC to OE) on the vertical axis of Figure 3. For the national endowment ratio, $\bar{K}_n/\bar{L}_n$, the range for incomplete specialization is DF. Therefore, DE represents along the vertical axis the range of factor prices over which both T_xT_y and $T_x'T_y'$ will show incomplete specialization. Consequently, for any goods price-ratio in the range DE (i.e., OD to OE) along the left-hand horizontal axis, it is evident that the choice of capital-labour ratios in X and Y will be identical for T_xT_y and for $T_x'T_y'$, and hence there will be a unique set of real factor prices (P_K/P_i and P_L/P_i, i = x,y) along both of these production possibility curves.[1/] Given this uniqueness, the value of national income ($\bar{L}_nP_L/P_i + \bar{K}_nP_K/P_i$, i = x,y) can be represented by the goods price-ratio tangent to T_xT_y, for the same reason that the value of aggregate income ($\bar{L}P_L/P_i + \bar{K}P_K/P_i$, i = x,y) is representable by the goods price-ratio tangent to $T_x'T_y'$. Thus, even though T_xT_y is only a hypothetical construct and national factors combine with foreign factors to produce at common techniques throughout the economy along $T_x'T_y'$, we can see immediately that the foregoing procedure for

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[1/] For ease of identification, Figure 3 is marked, both for P_K/P_L and for P_y/P_x, with identical lettering: C, D, E, and F. Thus, the factor price-ratio range DE corresponds to the goods price-ratio range DE. Similarly, the positioning of the letters C, D, E and F on the K_x/L_x and K_y/L_y schedules indicates, as noted in the text, corresponding points of specialization in production on T_xT_y and $T_x'T_y'$. Again, the lettering on T_xT_y and $T_x'T_y'$ in Figure 4 will correspond to the lettering in Figure 3, to facilitate grasp of the relationship between the two illustrations.

deriving the national budget line (by putting the goods-price ratio tangent to T_xT_y) will be valid as long as P_y/P_x is in the range DE.

Therefore, for this overlapping range (DE) of incomplete specialization, we can indeed proceed in Figure 4 to place the goods price-ratio tangent to T_xT_y to derive the national income line. Besides, a movement from D to E along T_xT_y and $T_x'T_y'$ will imply -- given the resulting rise in the wage-rental ratio and the condition $\bar{K}_n/\bar{L}_n < \bar{K}/\bar{L}$ -- a rise in the share of aggregate income going to domestically-owned factors.

Zone II: But vary now the goods price-ratio P_y/P_x down from OE in Figure 3. It is evident that there will be complete specialization on good X on $T_x'T_y'$ while, on T_xT_y, we would get incomplete specialization in production until the goods price-ratio becomes OF (Figure 3). Since the returns to domestically-owned factors must reflect what happens on $T_x'T_y'$, however, it follows that the relative rewards of K and L will remain fixed at P_K/P_L = OE in Figure 3 for all changes in the goods price-ratio from OE to OF and further.

Therefore, the share of national in aggregate income will also remain constant, for such variations in the goods price-ratio, at OQ/OE. The national income line therefore will become EQ in Figure 4 for the goods price-ratio OE in Figure 3 and will shift on its anchor Q thereafter to QS through QR as P_y/P_x falls steadily from OE to zero in Figure 3.

Clearly, therefore, the stretch EF on T_xT_y is not relevant to the determination of the national income line. The diminishing returns that it reflects as K/L ratios change with a varying goods price-ratio are, in fact, arrested because of the opportunity to combine with the foreign factors. The gain that such an opportunity represents for national factors is measured by the distance between: (1) the income line produced by

tangency of a goods price-ratio along EF in Figure 4; and (2) the parallel income line (anchored on Q) that actually obtains, thanks to interaction with the foreign factors and the consequent anchoring of the techniques and factor rewards at E on $T_x'T_y'$.

Zone III: Varying the goods price-ratio in the opposite direction, from OD upwards toward OC and beyond in Figure 3, then defines the remaining set of possible variations in the goods price-ratio.

At goods price-ratio OD, T_xT_y shows specialization on good Y and $T_x'T_y'$ shows incomplete specialization, in Figure 4. If factor prices were constant as P_y/P_x rises, T_xT_y would have led to continuous improvement in the national budget line, each successive budget line being anchored on D and rotating upwards. However, P_K/P_L is not fixed, but will continue to fall as the aggregate economy moves along $T_x'T_y'$ from D to C. Therefore, given the associated increase in the wage-rental ratio and the condition $\bar{K}_n/\bar{L}_n < \bar{K}/\bar{L}$, the share of national in aggregate income will rise with the move from D towards C on $T_x'T_y'$. However, the move to C from D is also accompanied by a declining intercept of the aggregate income line with the vertical axis. Therefore, while the former effect works to raise the national income line, the latter effect works to lower it.

It is possible to establish, however, that the combination of these two effects yields an unambiguously upward shift in the national income line, according to the following reasoning. The real value of national income in terms of good Y is given by $Q_y = \bar{L}_n P_L/P_y + \bar{K}_n P_K/P_y$. By differentiation of this equation, $dQ_y/d(P_L/P_y) = [\bar{L}_n/\bar{K}_n + d(P_K/P_y)/d(P_L/P_y)]\bar{K}_n$. Since the first-order conditions for profit maximization can be manipulated easily to show that

$d(P_K/P_y)/d(P_L/P_y) = -L_y/K_y$, then

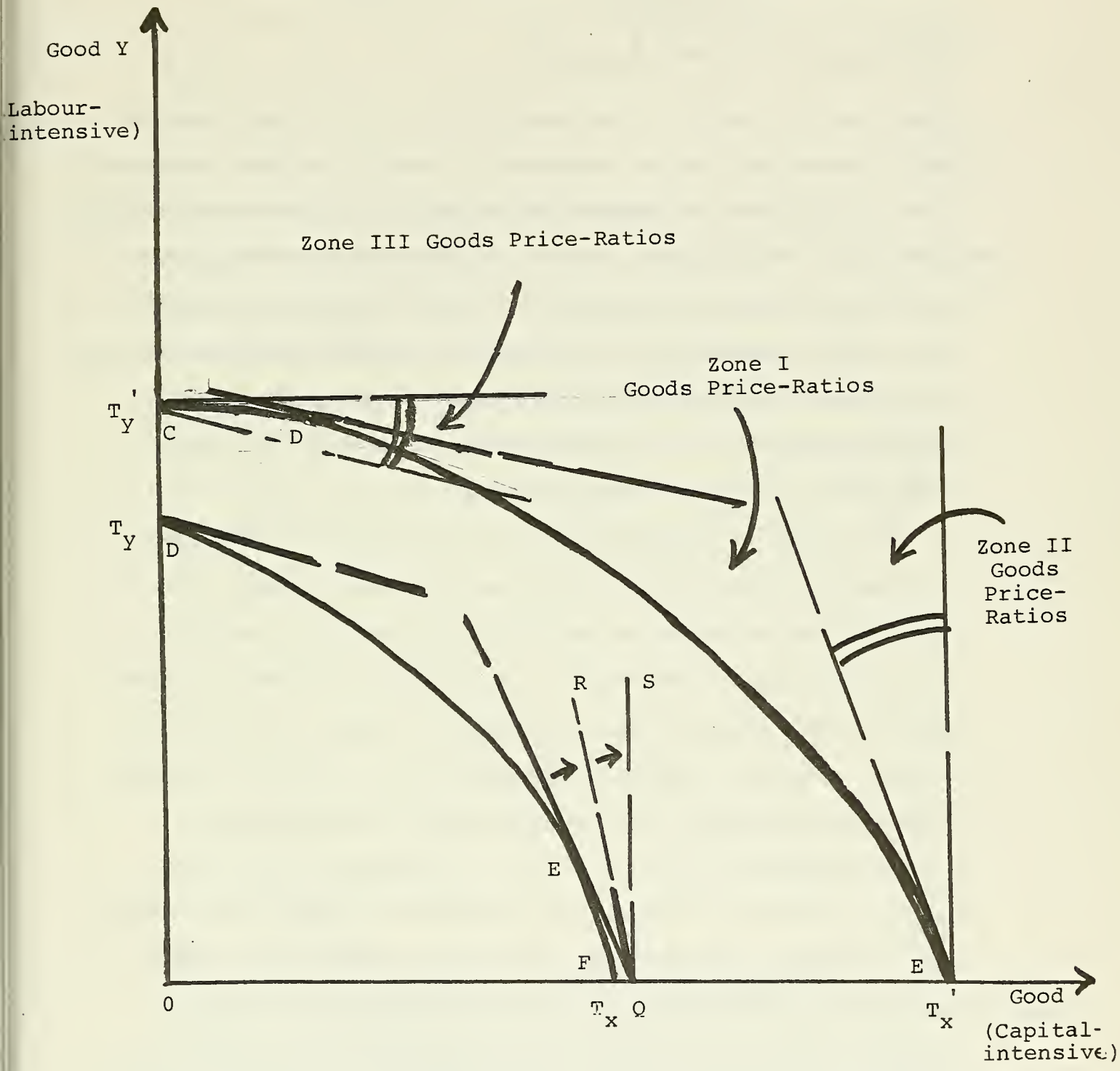
Good Y
(Labour-intensive)
Zone III Goods Price-Ratios
Zone I
Goods Price-Ratios
Zone II
Goods
Price-
Ratios
T_y'
C
D
T_y
D
R
S
E
F
E
0
T_x
Q
T_x'
Good
(Capital-intensive)

FIGURE 4

$dQ_y/d(P_L/P_y) = (\bar{L}_n/\bar{K}_n - L_y/K_y)\bar{K}_n$. Thus,

$dQ_y/d(P_L/P_y) \gtreqless 0$ because $\bar{L}_n/\bar{K}_n \gtreqless L_y/K_y$

within Zone III, with the strict equality holding only for the borderline case of goods price-ratio OD. Consequently, as P_L/P_y increases continuously with P_y/P_x (a la Stolper-Samuelson) within Zone III, Q_y rises correspondingly, and hence the national income line shifts upwards while becoming flatter.[1/] Once the goods price-ratio reaches OC in Figure 4, however, and specialization on good Y ensues at T_y' for the aggregate economy, successive increases in P_y/P_x will not change the share of national in aggregate income and the national income line will rotate upwards (along with P_y/P_x) from a fixed anchor on the vertical axis in Figure 4.

What happens in the goods price-ratio range from OD to OC is that the presence of foreign factors introduces diminishing returns, which would have been avoided if national factors had operated in isolation (at D in Figure 4). At the same time, a la Stolper-Samuelson, an "income-redistribution" phenomenon works to labour's and hence to national advantage. Apparently, however, the net impact on the national income line is unambiguously favourable in the general case for the sub-range of goods-price ratios $OD \leq P_y/P_x \leq OC$. For price-ratios in the sub-range $P_y/P_x > OC$, there is, of course, only a favourable rotation of the national income line as P_y/P_x improves and the economy is specialized on good Y. These two sub-ranges together define all the possibilities in Zone III.

[1/] Of course, $dQ_x/d(P_L/P_x) \geq 0$ also because $\bar{L}_n/\bar{K}_n \geq L_x/K_x$. Except for the borderline case of goods price-ratio OD, it is evident that $\bar{L}_n/\bar{K}_n$ exceeds both L_x/K_x and L_y/K_y as P_y/P_x varies from D to C and therefore both Q_y and Q_x will improve unambiguously with increase of P_y/P_x.

In concluding this section, note that the T_xT_y curve clearly would be of little use if $\bar{K}_n/\bar{L}_n$ were so much below $\bar{K}/\bar{L}$ that Zone I did not exist.[1/] In this case, we can see immediately that the situation can be described fully by the foregoing analysis of Zones II and III. Of course, it is clear that this case, where there is no Zone I, is implied by the Bhagwati-Tironi analysis where capital is wholly foreign and labour is wholly domestic. For, in this case, where the Stolper-Samuelson-Bhagwati-Johnson-Rao analysis can be applied directly, the overall factor endowment ratio is $\bar{K}/\bar{L}_n$ and the national endowment ratio is $\bar{K}_n/\bar{L}_n = 0$. Indeed, in this case, it is evident that national income in units of Y (Q_y) and of X (Q_x) will unambiguously rise as the real wage of labour rises in terms of both Y and X with the rise of P_y/P_x, a la Stolper-Samuelson.

[1/] If, as in the Bhagwati-Tironi analysis, there is only labour in the national endowment, and capital is essential for production, T_xT_y would shrink to the origin! Otherwise, in their model, it would have a Ricardian shape if capital is dispensable.

III: Welfare Implications in an Open Economy

The preceding analysis can be readily grafted onto two familiar problems of the theory of trade and welfare: (1) the welfare effects of exogenously-induced changes in the external terms of trade (as a result of some type of parametric shift abroad) under free trade, and (2) the welfare comparison of free trade and autarky. The discussion holds equally well for both the large-country and small-country cases, even though the magnitude of adjustment in the equilibrium value of international prices could depend upon the economy's degree of monopoly power in world trade.

(A) Exogenously-induced Changes in the Terms of Trade

As noted above, in the context of Figure 2, the conventional result, with a standard social utility function, is that improvements in the terms of trade monotonically improve welfare under free trade, given the pattern of trade. This result, however, does not hold necessarily in the presence of foreign factors of production. To see this, consider terms of trade variations within the three Zones distinguished in section II for the general case where Zone I also obtains. The analysis can be readily extended by the reader to terms of trade changes between the Zones.

(a) Changes within Zone I

Within Zone I, the domestic price-ratio (which is identical to the external terms of trade under free trade) can be put tangent to $T_x T_y$ to derive the national income line, as shown above in section II. It follows therefore that terms-of-trade improvement within Zone I ought to increase national welfare.

It should be observed, however, that a given change in P_y/P_x may mean both an improvement in the terms of trade for the economy as an aggregate and a simultaneous terms-of-trade deterioration from the national point of view. This apparent paradox is easily seen and quickly resolved, by noting simply that the equilibrium value of P_y/P_x may differ between aggregate autarky (along the actual production possibility curve $T_x'T_y'$) and national autarky (along the hypothetical curve T_xT_y), so that the aggregate (actual) pattern of trade may differ from the national (hypothetical) pattern of trade. For this reason, although national welfare improves monotonically with the national terms of trade, aggregate terms-of-trade improvement will not imply an increase in national welfare unless the aggregate and national patterns of trade happen to be the same.

This is illustrated in Figure 5, where the $T_x'T_y'$ curve has been omitted, to avoid cluttering the diagram. The aggregate-autarky price-ratio (determined along the omitted curve $T_x'T_y'$) is drawn tangent to T_xT_y at A'. The national-autarky price-ratio is tangent to T_xT_y at A. (To have ray OA' steeper than ray OA as drawn, a sufficient but not necessary condition is a unique set of homothetic indifference curves corresponding to both U^G and U^N, in view of the well-known Rybczynski Theorem.) For any reductions in P_y/P_x from A', U^G would have improved. However, for all such changes between A' and A, within the autarkic price-ratios cone AOA', U^N obviously declines because for national factors the aggregate terms-of-trade improvement is a terms-of-trade deterioration. Therefore, U^N declines steadily from $U^N_{A'}$, through U^N_1 to U^N_A. However, further declines in P_y/P_x will start improving U^N and Figure 5 shows the P_y/P_x at G which raises U^N back to the level A' consistent with the aggregate-autarky price-ratio. Obviously, then, still further decline

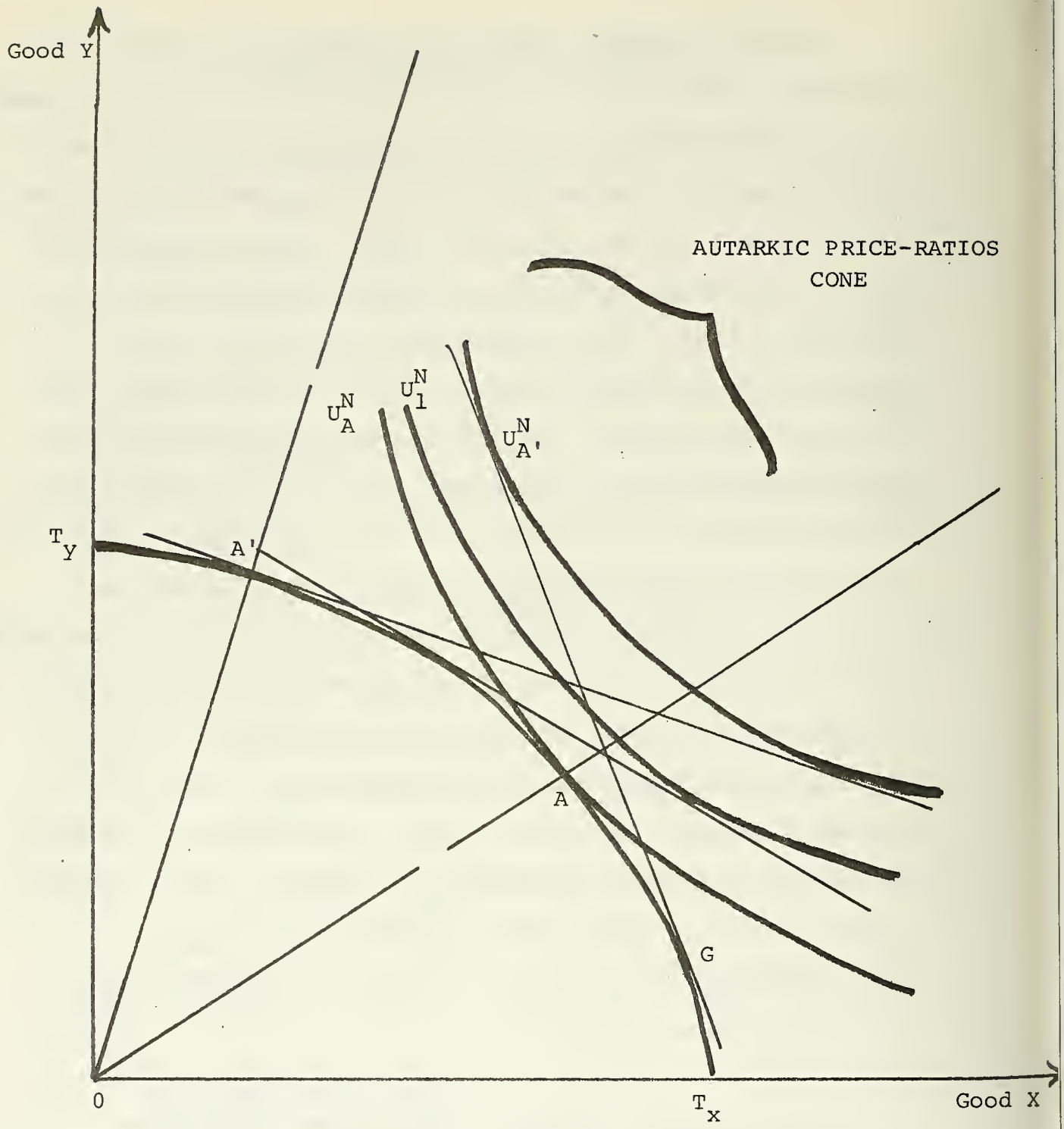
Good Y
AUTARKIC PRICE-RATIOS CONE
U_A^N
U_1^N
$U_{A'}^N$
T_Y
A'
A
G
0
T_X
Good X

FIGURE 5

in P_y/P_x would have raised U^N above the level at A'. It follows that the net result of terms-of-trade improvements for the aggregate economy may be to raise, lower or leave national welfare unchanged. This general result still would hold if ray OA' were flatter than ray OA. Only if the two rays coincided would aggregate terms-of-trade improvement necessarily imply an increase in national welfare.

(b) Changes within Zone II

Within Zone II, there is (aggregate) specialization on good X along $T_x'T_y'$ in Figure 4. It is evident then that any improvements in the aggregate terms of trade will imply corresponding improvements in the national terms of trade. For, successive rotations outwards of the national income line, anchored on Q, will produce increasing national welfare, U^N. Therefore, changes in U^G may be used to infer the direction of change of U^N: there is no complication as in Zone I.

(c) Changes within Zone III

Within Zone III, in the aggregate, there is first the range of incomplete specialization (up to C from D on $T_x'T_y'$ in Figure 4) and then complete specialization on good Y. For variations in the aggregate terms of trade within the incomplete-specialization range, our earlier analysis shows that the national income line must rise with P_y/P_x. By the same token, U^N must also rise with P_y/P_x. Thus, when P_y/P_x rises, U^N and U^G will move together or in opposite directions according as the economy (in aggregate) exports good Y or X, respectively. However, beyond the point of specialization on good Y, the aggregate terms-of-trade improvement (resulting from a rise in P_y/P_x) must also increase national income and therefore U^N. The net effect of terms-of-trade improvements in Zone III therefore may be to lower or increase national welfare when there is

incomplete specialization along $T_x'T_y'$, but must be to raise national welfare when aggregate specialization is complete on good Y. Note, moreover, that the contrary behaviour of U^N and U^G, possible in the case of incomplete specialization, does require that the aggregate pattern of trade be different from the national pattern of trade: for, such a possibility will arise if and only if the aggregate trade pattern involves the export of good X[1/] and the national trade pattern (owing to complete specialization on good Y, necessarily in Zone III) involves the export of good Y instead.

It is evident therefore that directional changes in national welfare generally cannot be inferred from the direction of changes in the terms of trade in the aggregate, if the economy is in Zones I and III. Interestingly, for both these Zones, the paradoxical behaviour of national welfare arises simply because the aggregate pattern of trade masks a contrary pattern of trade for the domestically-owned, national factors of production. If only we could draw aside the veil imposed by the presence of foreign factors, and see directly the national (hypothetical) equilibrium production and consumption, the paradox would have disappeared.[2/] Therefore,

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[1/] This is, in fact, the paradoxical case considered in Bhagwati and Tironi (1978), Section II, but without the underlying explanation and argumentation a la the national production possibility curve, as set out in this paper.

[2/] Of course, this does not mean that the paradox cannot arise if national and foreign tastes are homothetic. For, it is the difference in the trade pattern, as determined by the production and consumption choices at the specified goods price-ratio, that is the critical variable in creating the paradox in both Zones. Nor should the reader forget that the hypothetical national equilibrium production will reflect, in Zone III (as also Zone II, for that matter), the interaction with foreign factors: the national income line cannot simply be drawn by reference to T_xT_y alone by tangency of the goods price-ratio with it. In Zone I, however, the presence of foreign factors does nothing to affect the correctness of such a procedure.

the paradox has nothing to do with redistribution of income between foreign-owned and national factors a la Stolper-Samuelson. We may therefore describe the paradox of Zones I and III as arising from the Differential-Trade-Pattern phenomenon, rather than from any kind of income-redistribution effect. The redistribution of income a la Stolper-Samuelson does indeed take place in both Zones I and III; but it cannot, in itself, create the paradox of deterioration (improvement) in national welfare when the economy's terms of trade improve (deteriorate).

(B) Autarky versus Free Trade

Since neither free trade nor autarky creates tariff revenue, the analysis of this paper can be readily used also to rank these two trade policies in the presence of foreign-owned factors of production.

It is seen immediately that, in Zones I and III, the differential-trade-pattern phenomenon may lead to autarky (in the aggregate) being better for national welfare than free trade. (Zone II can be ignored at this stage in the discussion, since aggregate autarky cannot occur when only good X is produced along $T_x'T_y'$, assuming that aggregate consumption is always positive for each good.) Thus, the conventional welfare ranking (of free trade being superior to autarky) may be reversed, in the presence of foreign-owned factors of production within an economy.

Finally, there is a related departure from conventional wisdom to consider, in a small country, when national income is augmented to include tariff revenue (in addition to earned income), as a consequence of nonprohibitive taxes on trade. If U^N is greater under autarky than under free trade, then (by continuity) there must be a positive relationship between national welfare and the trade tax, at least within some tax interval. Thus the general theory of tariffs and welfare needs to be reconsidered, in the presence of factor inflows from abroad.

References

Bhagwati, Jagdish N. 1959. "Protection, Real Wages and Real Incomes." Economic Journal, December.

_____. 1971. "The Generalized Theory of Distortions and Welfare," in Jagdish Bhagwati et al. (eds.), Trade, Balance of Payments and Growth: Essays in Honor of Charles P. Kindleberger (North-Holland).

_____ and Ernesto Tironi. 1978. "Tariff Change, Foreign Capital and Immiserization: A Theoretical Analysis." MIT, mimeographed, August.

Johnson, Harry G. 1959. "International Trade, Income Distribution and the Offer Curve." Manchester School 27:241-260.

_____. 1960. "Income Distribution, the Offer Curve and the Effects of Tariffs." Manchester School 28: 215-242.

_____. 1965. "Optimal Trade Intervention in the Presence of Domestic Distortions," in Robert E. Baldwin et al. (eds.), Trade, Growth and the Balance of Payments: Essays in Honor of Gottfried Haberler (Rand McNally).

Rao, V. S. 1971. "Tariffs and Welfare of Factor Owners: A Normative Extension of the Stolper-Samuelson Theorem." Journal of International Economics 1:401-416.

Stolper, Wolfgang and Paul Samuelson. 1941. "Protection and Real Wages." Review of Economic Studies 9, November.

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